the supposed ancestors of the Artiodactyles from the Puerco (*Protogonodon* and perhaps other genera, as suggested by Professor Scott) the characters of the dentition are well differentiated from those leading to the Perissodactyles. I have referred upper teeth in the American Museum collection to Protogonodon, which are of the tritubercular type, with exceedingly brachydont crowns. These upper teeth differ considerably from those of the bunodont Creodonta. The internal cones and intermediate tubercles in Protogonodon have coalesced and nearly form crescents. The external cusps of these superior molars are depressed and not as conical in section as in the Puerco Creodonta. The lower true molars of Protogonodon are sexitubercular, but differ in form from those of most of the Creodonta by the fact that the anterior portion of the tooth (trigonid) is not raised above the posterior (talon). The cusps of the lower true molars, as in the case with those of the upper molars, coalesce and form continuous tracts of worn enamel; this applies particularly to the posterior limb of each crescent. Lastly, the upper premolars in Protogonodon are not yet known, but the lower teeth of this series are well preserved and shows them to be absolutely simple in structure, consisting of a cone with slightly enlarged heels. In some specimens there is a trace of an internal cusp on the last lower premolar.

The characters above adduced as pertaining to the dentition of Protogonodon approach closely those of the earliest known American Artiodactyle, viz., *Pantolestes* from the Wasatch Eocene, I would suggest accordingly that *Protogonodon* may stand in ancestral relationship to this genus.

I do not agree with Dr. Schlosser in deriving the Artiodactyles from any of the known Periptychidæ, as the latter group has been defined by Professor Cope. In nearly all of the Periptychidæ the premolars are highly specialized and are not adapted for further evolution. Professor Scott, in his very valuable paper on the "Creodonta," only recently published, has subdivided the genus *Mioclaenus* Cope into several new genera, limiting the latter genus for a few species only; the type being the *Mioclaenus turgidus*. The structures of the premolars in Mioclaenus are more like those of some of the Periptychidæ than the Creodonta, and consequently Professor Scott believes that Mioclaenus is a condylarth. Other than the genera already mentioned as probably having been persistent types, I would intimate that *Mioclaenus turgidus* may stand in ancestral relationship to some of the White River bunodont Artiodactyles (*Leptochœrus*). The following phylogenetic scheme may illustrate the affinities proposed in this paper:

Perissodactyla.	Bunodont Artiodactyla.	Selenodont Artiodactyla.	Amblypoda.
Euprotogonia.	Mioclaenus.	Protogonodon.	Pantolambda.

DO THE LEAVES OF OUR ORDINARY LAND PLANTS ABSORB WATER?

BY EDWARD A. BURT, EAST GALWAY, N.Y.

CONFLICTING answers have been given to this question. Hales, Boussingault, and Henslow concluded from their experiments that leaves do absorb water; other investigators have failed to obtain such positive results, and have been inclined to doubt absorption. Furthermore, the theory that the transfer of liquids is largely accomplished through differences in density of the liquids in the plant caused and maintained by transpiration from the leaves — this, by giving a sufficient function to the leaves, has probably deterred investigators from entering upon an inquiry that promised only negative results, and that was beset with difficulties in carrying out. Yet a moment's reflection shows us that during the growing season of several months in each year, our vegetation is covered with dew night after night, and often when periods of drought prevent the plants from receiving an adequate supply of water through their roots. Does it not seem probable that plants are able to use the dew which covers their leaves?

Under the direction of Professor Goodale and Mr. W. F. Ganong, the writer has been recently carrying on a series of experiments in the botanical laboratories of Harvard University to determine —

(*a*) Whether it is probable that leaves do absorb water.

(*b*) Whether the conditions under which such absorption occurs, if it does occur, will not afford suitable ground for more special investigation later on.

Some of the results already reached seem to justify a preliminary publication.

Can Leaves Absorb Water?

To decide this, young branches of Diervilla grandiflora, common house geranium (Pelargonium), and Mesembryanthemum were cut from the parent plants while in full leaf. The clean-cut ends of these small branches were then dipped into a waterproof varnish — Brunswick black — so as to completely cover the cut ends and the sides for an eighth of an inch up the stem. The branches were then allowed to lie on a table in the laboratory — temperature, 70° F. — for a time until wilting occurred. They were then weighed, sprinkled with water, and shut in a botanist's tin collecting-box for from 16 to 46 hours. Having recovered their original fresh condition, the branches were then removed from the box and dried carefully from adhering water by exposure to the air of the room and by the use of blotting paper. They were then weighed. In each case there was an increase in weight indicative of absorption. The details are given in the following table:—

	Period of wilting	Weight of wilted branches.	Time shut in the box.	Weight of water absorbed.
	Hours.	Grammes.	Hours.	Grammes.
Diervilla grandiflora	3	12.12	16	0.36
Common geranium (Pelargonium)	49	26 79	46	5.76
Mesembryanthemum (a succulent-leaved plant)	49	40.55	46	0.77

Henslow obtained absorption with cut branches in a large number of cases and under a variety of conditions; but as he did not cover the cut ends of his branches, it has been objected that the absorption in his experiments occurred through the cut ends rather than through the leaves. My experiments show that the objection was not well taken. We must conclude that slightly wilted leaves may absorb water.

Do Leaves of Rooted Plants Absorb Water?

Small vigorous-growing plants of Ricinus and of a small-leaved Begonia were used. They were obtained from the greenhouse in 2- and 3-inch pots. The pot and the lower portion of the stem of each plant were then inclosed in a covering of sheet rubber in the following manner: A small circular opening of less than half an inch in diameter was cut in the centre of a piece of sheet rubber of suitable size. The rubber was then stretched in the region of the opening so as to make the aperture temporarily larger. The pot was then slipped down through this opening.

Upon lessening the tension, the rubber contracted clasping the stem just below the lowest leaves. With a stout thread the rubber was then wound firmly against the stem for a sufficient distance to make a close contact of the two. With its centre suspended from the place where tied about the stem, the rubber now hung down covering the pot loosely and completely concealing it. The lower portions of the rubber were now gathered together underneath the pot and firmly tied together with strong cord.

A thrifty young begonia plant with its pot so covered had its leaves thoroughly sprayed with water by means of an atomizer at 6 P.M. It was then placed under a large bell-jar in an atmosphere made and kept damp by wetting the inner surface of the jar with water and by suspending in the jar two large sponges dripping wet. With its leaves wet, the plant was kept in this damp atmosphere in the dark during the night. In the morning it was removed from under the bell-jar, dried carefully, and then weighed at 8.40 A.M. It had increased its weight 0.09 grams

during the night. This increase must have been due to absorption of water by the leaves.

At 8.40 A.M. the bell-jar was removed to a window space and the damp atmosphere was obtained within the jar as before. The leaves of the plant were then thoroughly sprayed again and the plant was placed under the jar and left there in a strong light during the day. From time to time, as the water began to disappear from the leaves, they were resprayed. At 4 P.M. the plant was removed from the moist chamber and carefully dried. It was then weighed and showed a loss in weight since 8.40 A.M. of 0.41 grams.

On repeating the experiment with the same plant, the increase in weight was 0.04 grams during the night—from 6.15 P.M to 8.20 A.M. From 8.20 A.M. until 2.30 P.M., there was a decrease in weight (transpiration) of 0.23 grams.

But was the increase in weight during the night in these experiments really due to absorption of water by the leaves? May not the moist air surrounding the plant have passed through the rubber covering and deposited some of its moisture upon the earth or pot, thus giving absorption by the earth rather than by the leaves? Such an interpretation of the experiment is forbidden by the condition of the interior found upon opening the rubber covering at the close of the confirmatory experiment. (That condition was not *precisely* known while the experiments described were in progress, for the plant had been subjected to experiments for several weeks, during which time its growth had made it difficult to give to the plant amounts of water exactly equal to the amounts transpired from day to day). Upon opening the rubber covering, the earth in the pot was found wet to the touch, the pot was wet, and the whole inner surface of the rubber covering was wet. In this condition of things, the greater movement of the water must have been from within the pot *outward* through the rubber to its dry outer surface and the drier—comparatively drier—air surrounding it in the moist chamber. If such a movement of water did occur, its effect was that of diminishing the weight of the plant during the night. We must regard absorption by the leaves as the cause of the increase which really occurred.

How potent a factor light is upon the functions of the plant, is readily seen by a comparison of the changes in weight during the day in these experiments with the changes during the night. At night, in the darkness, absorption perceptible by the balance occurred; during the day, transpiration predominated although the leaves of the plant were kept wet with water and in a moist atmosphere. Is it not possible that some of the failures to find absorption by leaves may have come through nice quantitative experiments having been carried on in the daytime, as would be the more convenient?

In conclusion, the experiments so far as they have been carried, seem to show—

(*a*) That leaves may absorb water.

(*b*) That leaves of growing plants do absorb water during the night when they are wet with water and in a moist atmosphere —i.e., under dew conditions.

INDIVIDUAL SKELETAL VARIATION.

BY FREDERIC A. LUCAS, U. S. NATIONAL MUSEUM, WASHINGTON, D. C.

THE subject of individual skeletal variation is one of considerable interest, to the morphologist from the hints it may give concerning lines of descent, to the systematic zoölogist from its bearing on the specific units of classification and to the vertebrate paleontologist since he must mainly rely upon more or less fragmentary skeletons for the determination of species.

External variations are readily perceived, often easily accounted for by known conditions of environment, but the question how much may the skeleton of a given species normally vary is by no means easy to answer.

Unfortunately the problem is rendered all the more difficult from the fact that the large series of specimens necessary for its solution are seldom available, so that characters may be considered of specific value, or, on the other hand, as mere abnormalities, when they are really normal variations or, perhaps, due to changes brought about by age. The following notes are somewhat desultory in their character, but they are based on the observation of considerable series of individuals of the various species referred to, and are brought forward as suggesting the existence of a large amount of individual skeletal variation.

In the report of the U. S. National Museum for 1887–88, the writer gave at some length the results of the examination of a large series of bones of the Great Auk, a series that was particularly interesting from the fact that it represented adult individuals from one locality and one epoch, so that any variations might be considered normal, and not due to differences of environment, or to modifications that might gradually come about in the course of time, even were there no change in surrounding conditions.

It may be briefly said that the long bones were found to vary to the extent of one-fifth of their length, but that the most interesting variations in the skeleton were the tendency to develop a ninth, extra pair of ribs and the frequent presence of a small tubercle on the tarsus, just where a hind toe would be located.

Very nearly one sacrum out of every seven possessed facets, showing the former presence of an abnormal number of ribs, while but one twelfth of the tarsi showed the little tubercle referred to.

Professor Newton found almost equally great variability in the bones of the Dodo and Solitaire, birds of unusually restricted habitat, but this he ascribes very largely to the fact that the remains examined probably represented individuals from very different epochs.

Among mammals the Orang seems to exhibit an unusual tendency to variation, and a series of crania of this animal shows many individual peculiarities.

Doubtless these are shown by other portions of the skeleton as well, but, at the time a large series of Orangs was available, my attention was directed almost entirely to the skull, and it can only be said that this species has considerable range in point of size, adult males being from four feet to four feet eight inches in height.

The Orang is a striking example of the cranial changes brought about by age, these being so great that four species have been founded on characters which a sufficient number of specimens shows to be due to age alone.

Apart from these it may be said that the foramen magnum has hardly the same shape in any two skulls, while the nasals vary as much, being sometimes long and narrow, sometimes short and broad, and in one case quite absent.

The shape and size of the orbits is very variable and they may be close together or some little distance apart. At the same time the supra-orbital ridges are often larger in rather young Orangs than in very old individuals.

A rather curious feature in the Orang is the tendency to develop an extra molar, the normal number being three, as in man. Usually this additional tooth is in the lower jaw and unpaired, but one jaw possessed four perfect molars on either side.

Our Mule Deer shows great cranial variability, both in size and proportions, and while typical skulls of the Mule Deer, the Columbia Deer, and Virginia Deer may be recognized at a glance, in many instances, where the antlers have been shed it requires careful examination to distinguish the skulls of the species apart.

The tendency to develop an extra pair of ribs is not very uncommon among birds, and, as we know, is occassionally seen in mammals, where it may take the form of a short pair of ribs on what would normally be the first lumbar, much more rarely a rib, or pair of ribs, on the seventh cervical, and sometimes that of an unpaired rib on the first lumbar.

In cases of this last mentioned variant the odd rib is usually longer than when an extra pair of ribs is present.

The true sacrals of birds are ordinarily devoid of parapophyses, in fact this is one of their distinguishing characteristics, yet among Cormorants these processes are not infrequently present and I have once observed them in a Goatsucker.

Although it is not uncommon to meet with an additional pair of ribs among birds, any lessening of the normal number is very rare and only once has such a case come under my notice, this